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RESEARCH NOTE

CHARACTERISTICS AND DYNAMICS OF ILLEGAL FIREARMS MARKETS: IMPLICATIONS FOR A SUPPLY-SIDE ENFORCEMENT STRATEGY*

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The question of whether the illegal firearms market serving criminals and juveniles can be disrupted has been vigorously debated. Recent research suggests that illegal gun markets consist of both "point sources" (ongoing diversions through scofflaw dealers and trafficking rings) and "diffuse sources" (acquisitions through theft and informal, voluntary sales). To the extent that systematic gun trafficking is an important source of weapons for criminals and youth, focused regulatory and investigative resources may be effective in disrupting the illegal flow. In this research, we use data on traced firearms to examine one aspect of the illegal gun market that holds the most immediate promise for focused supply-side enforcement efforts—close-to-retail diversions. We find that almost one-third of traceable crime guns were recently diverted from legitimate retail firearms commerce and that nearly one-third had two or more indicators of gun trafficking involving dealers, purchasers, and possessors. We discuss the implications of these findings for understanding illegal gun markets and for developing effective supply-side enforcement strategies.

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In the United States, there are some 200 million privately owned firearms, including 70 million handguns (Cook & Ludwig, 1996). For juveniles and others prohibited legal firearm ownership, this immense stockpile makes available what would otherwise not be. The pervasiveness of guns in the United States suggests to some that it is simply not feasible to prevent people barred by law from possessing firearms from obtaining them if they are so inclined. Gun control restrictions on commerce and possession of firearms are, it is argued, futile (see Wright, 1995). Others suggest that even in gun-rich environments supply-side enforcement strategies directed at reducing access by those who are legally proscribed can be effective in reducing the prevalence and use by criminals and juveniles (see Cook & Braga, 2001; Braga, Cook, Kennedy, & Moore, 2002).

Although there is much debate about proper control measures to reduce legal access to guns, there is too little emphasis on the fact that only about one of every six firearms used in crime is obtained legally (Reiss & Roth, 1993). Firearms violence in the United States has been linked to the workings of illegal gun markets (Blumstein & Cork, 1996). Further, two of the riskiest populations, adult career criminals and juveniles, are prohibited from buying handguns legally nearly everywhere in the United States. Clearly, there is a problem with illegal acquisition from both regulated and unregulated sources, and a corresponding need for more effective interventions to prevent illegal transfers. Unfortunately, the complexity of illegal markets and scarcity of information about their workings present substantial challenges to policymakers and law enforcement officials interested in disrupting the supply of guns to those prohibited from owning them.

A major step in moving toward effective intervention strategies and tactics is developing a more comprehensive understanding of the character and dynamics of illegal firearms markets. This study suggests that strategic analyses of Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF) trace data on crime-related firearms recovered by law enforcement could provide valuable substantive insights into the character of illegal firearms markets. The knowledge gained from this analysis could also provide potentially useful tactical information to law enforcement agencies to develop problem-oriented interventions to shut down or disrupt illegal supply lines of guns.

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LEGAL AND ILLEGAL COMMERCE IN FIREARMS

Legal firearms commerce is comprised of transactions made in the regulated primary and the largely unregulated secondary firearms markets. Those and sales of new and secondhand firearms conducted through Federal Firearms Licensees (FFLs) are the primary market (Cook, Molliconi, & Cole, 1995). Once a gun is in private hands, it can be transferred any number of ways, whether by classified ads in newspapers and gun magazines, at gun shows (which include both licensed and unlicensed dealers), or in a private sale. These transactions of secondhand firearms by unlicensed individuals are the secondary market. No records are kept and criminal background checks are not required (Cook et al., 1995). About 30 to 40% of all gun transactions occur here (Cook & Ludwig, 1996). The two markets are closely linked because many buyers move from one to the other depending on relative prices and other terms of the transaction (Cook & Leitzel, 1996). As regulations tighten in the primary market, Cook and his colleagues (1995) suggest that the unregulated secondary market will become increasingly attractive.

Survey research suggests that theft from private citizens is an important source of firearms for criminals (Bureau of Justice Statistics, 1993; Wright & Rossi, 1994; Sheley & Wright, 1995). However, analyses of ATF firearms trace data and trafficking investigation data reveal that the illegal diversion of firearms from commercial businesses and legitimate firearms commerce are also important sources (see Braga & Kennedy, 2001; Wachtel, 1998; Kennedy, Piehl, & Braga, 1996; Pierce, Briggs, & Carlson, 1995; Moore, 1981). Through crime gun tracing, trace analysis, investigative work, and the help of outside researchers, ATF has developed a more refined picture of the complex illegal firearms market. Its components include: trafficking in new firearms, interstate and intrastate, by licensed firearms dealers (including

pawnbrokers), large-scale straw purchasers or straw purchasing rings, and small-scale straw purchasers (i.e., legally entitled purchasers buying one or a few guns for prohibited persons); trafficking in used firearms, interstate and intrastate, by licensed firearms dealers (including pawnbrokers), large-scale straw purchasers or straw purchasing rings, small-scale straw purchasers, unregulated private sellers (operating at gun shows and flea markets, through want ads, the Internet, and personal associations), and bartering and trading within criminal networks; and trafficking in new and used stolen firearms involving theft from licensed dealers and pawnbrokers, organized fencing of stolen guns, common carrier (such as United Parcel Service) theft, manufacturer theft, and household theft (ATF, 2000a; ATF, 2000c).

Survey estimates suggest that, as an upper bound, almost half of all crime guns may be stolen (see Wright & Rossi, 1994). Conversely, this suggests that at least half of crime guns are transferred in one or a series of primary and/or secondary market transactions. Judging the importance of non-theft leakage from the primary and secondary markets relative to one another is difficult with available data. Analyses of firearms trace data indicate that new firearms are more likely to be used in crime than are older firearms (see Kennedy et al., 1996; Cook & Braga, 2001). One-third of Wright and Rossi's (1994) male prison inmates reported that their most recently acquired handgun was new rather than used and 21% bought from a retail outlet. The acquisitions from FFLs could have occurred in a variety of ways: buys from corrupt FFLs; theft from FFLs (3% of Wright and Rossi's [1994] respondents stole their most recent gun from a gun store); buys from FFLs through fraudulent means, including straw purchases, false identification, or false information about buyer eligibility; or legal buys from FFLs (some respondents may have had clean records at the time of their most recent purchase). Thus existing research indicates that both the primary and the secondary markets are important sources of guns for prohibited users. This analysis focuses on those factors associated with the diversion from primary market sources.

The Prospects of Supply-side Enforcement

In their review of the various sources of data on the illegal supply of firearms, Braga and his colleagues (2002) suggest that, in the parlance of environmental regulation, illegal gun markets consist of both "point sources"—ongoing diversions through scofflaw dealers and trafficking rings—and "diffuse sources"—acquisitions through theft and informal voluntary sales. A reasonable conclusion is that, as with pollution, both are important

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(see Cook & Braga, 2001). Braga and his colleagues (2002) also speculate that the mix of sources differs across jurisdictions depending on the density of gun ownership and the strictness of gun controls. For example, systematic gun trafficking from retail point sources may be more difficult in jurisdictions with stricter controls on the purchase and sale of firearms such as Boston and New York than in jurisdictions with more lenient controls such as Atlanta and Dallas. Given that there is a mix of concentrated and diffuse sources, the potential effectiveness of supply-side enforcement may also vary across jurisdictions. Unfortunately, there is little direct evidence that successful regulatory and enforcement actions on point sources will actually reduce availability and hence gun use in crime. More research on the structure of illegal gun markets and experimentation with market disruption tactics is sorely needed.

From a policy perspective, the point and diffuse sources approach to the structure of illegal gun markets provides law enforcement with a framework to think about developing focused supply-side enforcement strategies appropriate to the characteristics and dynamics of local illegal gun markets. This new perspective is based on a synthesis of research evidence and its use has not yet been examined using ATF firearms trace data on the nature of gun markets in U.S. cities. In this research, we assess the potential of firearms trace information on illegal gun markets to identify problem point and diffuse sources of illegal firearms, and make observations on the prospects of focused supply-side enforcement strategies.

FIREARMS TRACE DATA

Firearms Tracing Process

The Gun Control Act (GCA) of 1968 established a set of requirements that allowed for any given firearm to be traced from its manufacture or import through its first retail sale. Each new firearm, regardless of origin, must be stamped with a unique serial number. Manufacturers, importers, distributors, and FFLs are required to maintain records of all firearms transactions, including sales and shipments received. FFLs must report multiple handgun sales and stolen firearms to ATF and provide transaction records to ATF in response to trace requests. When FFLs go out of business, they are to transfer their transaction records to ATF, which then stores them for tracing (ATF, 2000b).

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The tracing process begins with a law enforcement agency submitting a request to ATF's National Tracing Center (NTC). The form requires information regarding the firearm type (pistol, revolver, shotgun, rifle, etc.), the manufacturer, caliber, serial number, and importer (if the gun is foreign), the location of the recovery, the criminal offense associated with the recovery, and the name and date of birth of the firearm possessor (ATF, 2000b). This information is entered into ATF's firearms tracing system at the NTC and checked against the records of out-of-business FFLs stored by ATF, and records of multiple handgun purchases reported on an ongoing basis by FFLs. If the gun does not appear in these databases, NTC contacts the firearm manufacturer (for domestic guns) or the importer (for foreign guns) and requests information on the distributor that first handled the gun. ATF then follows the chain of subsequent transfers until it identifies the first retail seller. That FFL is then contacted with a request to search his or her records and provide information on when the gun was sold and to whom.

In 1999, law enforcement agencies submitted 164,137 firearm trace requests. Of these, 52.1% (85,511) were successful. The 47.9% that were not failed for a variety of reasons: nearly 10% (15,750) because the guns were too old (pre-1968 manufacture), another 11% (17,776) because of problems with the serial number, and the majority of the remainder because of error on the submission forms or problems obtaining the information from the FFL that first sold the gun at retail. It is important to note that, even when successful, a trace provides limited information about the history of the gun (Cook & Braga, 2001). Most successful traces access only the data on the dealer's record for the first retail sale. Subsequent transactions cannot generally be traced through the records federal firearms laws require.

Use of Firearms Trace Data to Examine Illegal Gun Markets

Understandably, research studies based on analyses of firearms trace data have been greeted with a healthy dose of skepticism. Trace analyses are subject to a number of widely recognized problems (see Kleck, 1999; Blackman, 1999; Congressional Research Service, 1992). All are based on firearms recovered by police and other law enforcement agencies, which may not be representative of guns possessed and used by criminals. Another factor is which guns are submitted for tracing, a decision made by law enforcement agencies. Not all firearms can be traced. All resulting information is thus biased to an unknown degree.

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Trace analysis cannot show directly whether a firearm has been trafficked. Trace studies typically contain information about the first retail sale of a firearm and about the circumstances associated with its recovery by law enforcement but cannot directly show what happened in between: whether a firearm was legitimately purchased and subsequently stolen, sold improperly by a licensed dealer, or any other of numerous possibilities.

The quality of firearms trace data has improved significantly over the past decade. Beginning in 1993, the Clinton administration was concerned about the apparent ease with which criminals and juveniles obtained guns. ATF was charged with initiating a concerted effort to increase the amount of crime gun tracing, improve the quality of firearms trace data, increase the regulation of gun dealers, educate law enforcement on the benefits of tracing, and increase investigative resources devoted to gun traffickers (Cook & Braga, 2001). Comprehensive tracing of all firearms recovered by police is a key component of ATF's supply-side strategy. In 1996, ATF initiated the Youth Crime Gun Interdiction Initiative (YCGII) with commitments from 17 cities to trace all recovered crime guns (ATF, 1997). This program expanded to 38 cities in 1999 (ATF, 2000c). Other jurisdictions have also expanded their use of gun tracing: Six states, for example, have recently adopted comprehensive tracing as a matter of state policy, either by law (California, Connecticut, North Carolina, and Illinois), by executive order (Maryland), or by law enforcement initiative (New Jersey) (ATF, 2000c).

Comprehensive tracing of all firearm recoveries reduces some of the bias in trace data introduced by police decision making. Jurisdictions that submit all confiscated guns for tracing can be confident that the resulting database of trace requests is representative of a well-defined "population" of guns recovered by police during a particular period and a reasonable "sample" of guns used in crime (Cook & Braga, 2001). Using recovered crime guns as a basis for estimating the characteristics of all guns used in crime is analogous to using arrestees as a basis for estimating the characteristics of all criminals. Although both are unrepresentative of the relevant populations in various ways and both are influenced heavily by police priorities and procedures, the validity of the conclusions drawn from these data depends on the application and the care taken to provide appropriate qualifications (Cook & Braga, 2001).

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ANALYSIS

Our analysis focuses on crime-related firearms recovered during calendar year 1999 and traced by NTC. We examine both the pool of all 1999 crime guns recovered in the United States and all 1999 crime guns recovered in seven YCGII cities that were study sites in the National Institute of Justice grant that supported this research. We selected 1999 because this was the first year that NTC traced all firearms to their first retail sale regardless of the length of time between first retail sale and subsequent recovery in crime.[1] Although most major cities participate in the YCGII program, the national data are not representative of all crime guns recovered by law enforcement agencies in 1999 because they include guns submitted for tracing from jurisdictions that do not engage in comprehensive tracing practices and, as such, are biased to an unknown degree. The city-level analyses can be considered representative of guns recovered by police during a particular period in a specific city and a reasonable sample of guns used in crime in a specific city (Cook & Braga, 2001). In this analysis we examine traced firearms from seven established YCGII cities that provided reasonable geographic representation for the nation: Baltimore, Boston, Memphis, Milwaukee, New York, Philadelphia, and San Antonio.

The analysis is divided into three parts: an examination of selected characteristics of illegal gun markets, a bivariate and multivariate analysis of indicators of illegal gun markets, and a multivariate examination of potential point and/or diffuse sources of trafficked guns as an exploratory assessment of their possible use in problem-oriented law enforcement initiatives.

The analysis focuses on a critical dimension of the illegal firearms market: the time between a firearm's first sale at retail and its subsequent recovery in crime ("time-to-crime"). Law enforcement investigators consider that a short time-to-crime suggests that a firearm may have been recently and illegally diverted from a retail outlet (ATF, 2002). For investigative and tactical purposes, guns with quick time-to-crime offer law enforcement an opportunity to identify illegal gun traffickers. New guns have passed through fewer hands, making it much easier for law enforcement to investigate potential trafficking and to mount prosecutions. Records are likely to be more complete and more available; individuals listed on paperwork are easier to find; guns

[1] Prior to 1999, ATF made policy decisions to not trace guns that were manufactured after 1990 (Kennedy et al., 1996).

are less likely to have been resold, given away, or stolen; and the chain of transfers to illicit consumers is likely to be shorter (Kennedy et al., 1996).[2] As such, the gun market analysis draws on the 82,737 firearm traces with a time-to-crime for crime guns recovered in 1999 (50.4% of 164,137).[3]

We use both national and city data to examine basic characteristics of illegal gun markets. The national data are used for the analysis of trafficking dynamics because they can presumably identify a broader and less idiosyncratic set of factors that affect the operation of the markets. ATF investigative and regulatory experience has documented that the workings of city-level markets can vary considerably as they are influenced by local factors such as state and municipal laws, levels of private gun ownership, and local gun enforcement practices (ATF, 2000a; ATF, 2000c).

Characteristics of Illegal Firearms Markets

Selected characteristics of crime gun related firearm traces for 1999 are presented in Table 1. Handguns are the most frequently traced weapon in the United States, accounting for nearly 74% of all traced firearms in 1999 (see Table 1a). Among handguns, there is a strong preference for semiautomatic pistols, which represent 45.9% of all trace requests. As with the national data, handguns accounted for the largest percentage of crime guns recovered in each of the seven cities. Philadelphia had the highest percentage of semiautomatic pistols (63.0%), followed by New York (53.1%), Milwaukee (51.3%), Memphis (49.3%), San Antonio (45.2%), Boston (43.9%), and Baltimore (43.3%).

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[2] In addition to experience of ATF investigators, empirical research provides support for the value of time-to-crime as an important indicator of firearms trafficking. Survey data suggest that diversions from retail outlets are important sources of guns for criminals. For example, Shelely and Wright (1995) found that 32 percent of juvenile inmates had asked someone, typically a friend or family member, to purchase a gun for them in a gun shop, pawnshop, or other retail outlet. This purchasing arrangement is known as a "straw purchase" and is a pattern of trafficking that is likely to result in crime guns with relatively short time-to-crimes. Another important source of evidence on this question is available by examining the over time (or age) distribution of crime guns relative to the age distribution of firearms manufactured for sale in the United States. Research indicates that the age distribution of crime guns is disproportionately new when compared to the age distribution of firearms manufactured for sale in United States over similar time period (Pierce et al., 2003). The age distribution of crime gun along with the experience of ATF investigators and evidence from survey research provide significant support for utility of time-to-crime as an indicator of trafficking.

[3] It is also important to note here that the exact number of traces reported in any analytic category will vary depending on the information available for that category. For example, the possessor of the recovered crime gun is not always known or reported to ATF. Therefore, an analysis of the number of traces associated with known possessors will necessarily be a smaller number than the total pool of traces.

Crime guns that change hands before being recovered by law enforcement agencies may indicate a problem with illegal diversion of firearms from legitimate commerce. Not all firearm traces, however, yield information on the possessors and first purchasers of the crime gun (Table 1b). In this study, only 64.8% of all traced firearms identified possessors, 50.3% identified purchasers, and 34.8% identified both.[4] We found that only 11.2% of guns recovered were in the possession of the original buyer. Among the selected cities, this percentage was much smaller in Memphis (2.7%), Boston (3.1%), and New York City (5.4%). It is important to remember that guns are durable goods and can change hands many times. Most recovered crime guns have changed hands at least once. However, new crime guns that changed hands before recovery may be a much stronger indicator of illegal gun trafficking.

Table 1. Characteristics of Traced Crime Guns, 1999

	National	Balto.	Boston	Memphis	Milwaukee	NYC	Phila.	San Antonio
a. Type of Gun								
% Handguns	73.5%	73.9%	73.2%	80.2%	72.6%	82.8%	88.1%	69.2%
% Semiauto	45.9%	43.3%	43.9%	49.3%	51.3%	53.1%	63.0%	45.2%
N	(164,137)	(3,783)	(611)	(3,617)	(2,480)	(7,334)	(3,293)	(1,563)
b. Purchaser and Possessor Same Person								
% Same Person	11.2%	10.2%	3.1%	2.7%	15.8%	5.4%	12.8%	12.4%
N	(57,123)	(1,454)	(130)	(1,513)	(1,142)	(1,808)	(1,618)	(831)
c. Distance between Recovery and First Sale Location								
% <=25 miles	45.5%	52.5%	31.3%	49.1%	60.2%	14.0%	63.4%	50.4%
% >100 miles	42.5%	37.7%	52.6%	42.6%	30.8%	75.0%	29.5%	42.9%
N	(52,704)	(2,216)	(249)	(326)	(1,514)	(2,482)	(1,673)	(1,128)
d. Recovery State and Sales State								
% Same State	65.1%	57.4%	33.6%	54.3%	70.8%	17.4%	70.4%	79.2%
N	(82,737)	(2,512)	(307)	(2,504)	(1,532)	(4,027)	(1,980)	(1,154)
e. Time-to-Crime								
% < 4 years	31.2%	27.9%	21.9%	34.6%	46.1%	20.7%	44.9%	24.4%
N	(82,737)	(2,039)	(233)	(1,941)	(1,307)	(3,113)	(1,738)	(903)

Illegal firearm markets can also be examined in terms of distance between the original retail sale of the firearm and its

[4] Identification of the individuals was based on individual identifier constructed from the first two letters of a person's first name plus the first three letters of a person's last name plus their month and year of birth and their state of residence.

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ultimate recovery by law enforcement.[5] Dealer-to-recovery distance provides a measure of the geographic distribution of gun markets within a given region (Table 1c). Examination at the national level reveals a highly bimodal distribution of dealer-to-recovery distances. Of the 69,593 traces where the location of the retail dealer and the gun recovery location could be determined, 45.5% of crime guns were recovered within 25 miles of the original retail dealer and 42.5% more than 100 miles away. At the national level also, a majority of traced crime guns were recovered in the same state as first retail purchase (Table 1d). About 65% were recovered in the same state as the first retail dealer and about 35% in another state.

The geographic distribution of the sources of traced guns recovered in the study cities show generally bimodal distributions, as do the national data, although across the seven cities there is considerable variability. Thus crime guns recovered in Baltimore, Memphis, Milwaukee, San Antonio, and Philadelphia were more likely to originate from local dealers (i.e., dealer within 25 miles of where they were recovered) than in either New York or Boston (Table 1c). However, traced crime guns in New York (75.0%) and Boston (52.6%) were more likely to have been first purchased more than 100 miles away when compared to the other study cities. Guns recovered in New York (82.6%) and Boston (66.4%) were much more likely to originate from other states (Table 1e). Relative to the other cities, New York and Boston are in states with much stricter gun controls, and criminals and juveniles have more difficulty acquiring guns through retail dealers. As such, a higher percentage of guns are imported into these cities from dealers in states with weaker controls (see Cook & Braga, 2001; Kennedy et al., 1996).

Finally, illegal firearm markets can also be examined in terms of time-to-crime. Fast time-to-crime guns represent a substantial share of crime guns recovered. Some 31.2% of all traced crime guns had been first sold at retail fewer than 4 years prior to their recovery in crime (Table 1e). This varies across the cities with Boston (21.9%) and New York (20.7%) having the lowest percentages of fast guns, and Milwaukee (46.1%) and Philadelphia (44.9%) having the highest.

As Pierce and his colleagues (1995, 2003) suggested, the distribution of crime gun traces to retail dealers is highly skewed. At the national level, only 1.2% of 80,523 active licensed dealers were associated with 54.6% of the successfully traced crime guns in 1999.

[5] Distance in this case is measured in terms of miles between the centroid of the zip code of the first retail gun dealer and the centroid of the zip code of the recovery location of the firearm.

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Fast time-to-crime guns were also concentrated among a fraction of licensed dealers; only 1.1% of all active retail gun dealers generated 63.7% of all fast time-to-crime traces. This suggests that the problem of fast time-to-crime guns not only varies across geographic locations but also tends to be concentrated among relatively few dealers.

Fast time-to-crime firearms recovered from possessors who were not the first retail purchasers present much stronger evidence that these firearms may have been illegally diverted from legal commerce. For the 19,017 fast time-to-crime guns for which information on the first purchaser and the possessor was available, 80% were recovered from secondary possessors. Although some fraction of these could involve the same person using false identification, the finding suggests that recently purchased crime guns usually change hands at least once before being used in crime, possibly via straw purchasers. However, in making the case for supply-side enforcement, the distinction between false identification and a straw purchaser actually does not matter much. It remains true that illegal transactions are occurring at or near the time of first retail sale (Cook & Braga, 2001).

Analysis of Illegal Gun Market Dynamics

A broad range of potential indicators of gun trafficking can be derived from ATF crime gun trace data. Our goal is to better understand the factors affecting illegal gun markets and assess whether this information can be useful to law enforcement in developing strategies and tactics to control illegal firearms trafficking.

Analysis of time-to-crime follows potential trafficking indicators through the decisions and actions involved in trafficking. Variables are grouped as they relate to different actors (e.g., dealers, purchasers, possessors) in the trafficking sequence. This is potentially important because different actors may have access to different resources, have different motivations, respond differently to law enforcement initiatives, and represent a different level of danger to society.

The categories examined here include dealer related activities and/or conditions, purchaser characteristics and behavior, purchaser/possessor relationships, possessor characteristics and behavior, and crime gun characteristics. Other control variables that might be predictive are also included to both improve our understanding of illegal gun markets and to help ensure we do not spuriously attribute predictive effects to the investigator-related indicators of firearms trafficking.

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At the dealer level, we examine time-to-crime by the number of traces to an active dealer from a given recovery area; the number of multiple sale firearms sold by an active dealer; the number of follow-up request letters sent by ATF to an active dealer; the number of National Instant Check System (NICS) denials by an active dealer; the shelf life of the traced firearm sold by active dealers; the stringency of purchaser gun laws in the states where crime guns were purchased, and the type of dealer (retail gun store, pawnshop, other).[6]

The number of NICS denials for a specific dealer was used to control for the illicit demand for guns a particular dealer faces, as measured by the number of criminals attempting to illegally purchase firearms from that dealer. We controlled for whether a licensed dealer was a pawnshop to account for the potential propensity of illegal buyers to gravitate towards nonstandard commercial establishments. We felt it was important to control for both variables because the number of traces a dealer generates might simply be linked to the number of criminals intent on buying from that dealer rather than any improper sales practices. Finally, we also examined restrictive state gun laws that make it more difficult to obtain firearms for illegal purposes from the retail market and thus result in longer time-to-crime for recovered crime guns. The states included in the restrictive gun law group were Connecticut, Massachusetts, Michigan, Missouri, New Jersey, and New York.

At the purchaser level, we examine time-to-crime by the total number of traces to a purchaser's home zip code, age of the purchaser, and number of traces associated with a given purchaser. For relationships between purchasers and possessors, we examine time-to-crime by the residential proximity between the purchaser and possessor in miles; age proximity between the purchaser and possessor; potential family relationships between them; whether the purchaser was a known associate of the possessor; and the residential proximity of the associate to the purchaser in miles. At the possessor level, we examine time-to-crime by the total number of traces to the crime gun possessor's home zip code of a crime and the age of the possessor. Finally, we also look at time-to-crime by the type of firearm (semiautomatic pistol, revolver, shotgun, or rifle),

[6] There is no national database of dealer sales volume to examine the potential effect of dealer sales on time-to-crime. However, research being conducted using California Dealer Record of Sale data (correspondence with Garen Wintemute, 2003) finds that the Pearson Correlation between the volume of gun sales by a given dealer (among dealers with 100 or more guns sales in a year) and the median time to crime for crime guns traced back to a dealer is only .08.

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and whether the gun was reported stolen when run against National Crime Information Center (NCIC) records.

For the possessors of traced crime guns, the control variables include the number of traces from the possessor's home zip code (based on the possessor's residence) and dummy variables for possessor age. Previous research has revealed that time-to-crime is related to the age of the possessor (Kennedy et al., 1996; ATF, 2000c); younger possessors are associated with newer crime guns. We also included dummy variables for purchaser age to control for any reductions in time-to-crime associated with the age of the first retail purchaser. This may be important because younger purchasers have had relatively less time to buy and may therefore be more likely to be associated with shorter time-to-crime firearms. Crime gun related variables include a dummy identifying a crime gun as a semiautomatic pistol, dummies identifying the manufacturer of selected crime guns, and a dummy for crime guns that were identified as stolen from National Crime Information Center records. Previous research has revealed that the type (e.g., semiautomatic pistol) and manufacturer (e.g., Lorcin Engineering) of crime guns are significantly related to time-to-crime (Kennedy et al., 1996; ATF, 2000c). These variables were located last in the substantive/temporal category of activities that result in the illegal diversion of firearms because they represent the summation of decisions made at earlier stages by dealers, purchasers, and possessors.

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Bivariate Analysis of the Illegal Diversion of Firearms from Retail Sources

We examine the relationship between time-to-crime (i.e., the percentage of crime guns with a time-to-crime of fewer than 4 years) by potential dealer-related indicators of gun trafficking (see Table 2). The percentage of short time-to-crime guns rises with the number of traces from a given dealer to a given recovery city (see Table 2a). Although this pattern does not necessarily mean that the dealer is involved in criminal activity or negligent business practices, dealers generating a large number of guns recovered should receive closer law enforcement and regulatory scrutiny than others. For active dealers with more than 11 crime gun traces from a given recovery city, nearly 54% of the traced guns had a time-to-crime of fewer than 4 years.

ATF investigative experience suggests that quick time-to-crime guns that were part of a multiple gun sale are likely to be guns illegally diverted from retail sources (ATF 2000a). The percentage of short time-to-crime guns from a given dealer

increases as the number of multiple gun sales made by the dealer increases (Table 2b). For dealers associated with more than 50 multiple sale guns, nearly 51% of the traced guns associated with the dealers had a time-to-crime of fewer than 4 years.

The shelf life of a firearm may be an important indicator of gun trafficking. The longer a firearm remains in a dealer's inventory, the more likely it is that the firearm may be sold at a discounted price to facilitate a sale. In examining the relationship between time-to-crime and the shelf life of a crime gun (Table 2c), we see that time in inventory is inversely related to time-to-crime.

Table 2. Time-to-Crime by Dealer Level Indicators for Dealers Active in 1999

a. Traces from an Active Dealer to a Given Recovery City

	1	2	3-5	6-10	11-25	25-50	51+	Total
% under 4 years	34.0%	42.5%	47.8%	51.8%	53.6%	53.0%	54.4%	43.0%
Total	(19631)	(4064)	(4833)	(3167)	(4224)	(2787)	(4956)	(43662)

b. Multiple Sale Firearms Sold in 1999 by an Active Dealer

	0	1-10	11-25	25-50	51-100	101-250	251+	Total
% under 4 years	33.9%	43.5%	43.7%	48.0%	48.9%	50.1%	54.4%	43.3%
Total	(16737)	(7457)	(5108)	(5191)	(5845)	(7532)	(4113)	(51983)

c. Shelf Life in Days of a Firearm Sold by an Active Dealer

	0-10	11-30	31-90	91-182	183-365	365-730	731+	Total
% under 4 years	39.7%	39.8%	40.5%	38.9%	40.2%	42.6%	57.4%	40.8%
Total	(7987)	(9682)	(12948)	(7214)	(5065)	(2947)	(2067)	(47910)

d. 13-Day Request Letters in 1999 to an Active Dealer

	0	1	2	3,4	4-9	10+	Total
% under 4 years	41.2%	42.3%	43.9%	48.7%	44.2%	58.6%	43.3%
Total	(29007)	(8525)	(3941)	(4913)	(3080)	(2517)	(51983)

e. NIC Check Denials in 1999 by an Active Dealer

	0	1-5	6-10	11-25	26+	Total
% under 4 years	41.6%	39.2%	44.3%	49.0%	46.5%	43.4%
Total	(24479)	(7077)	(5983)	(8559)	(5729)	(51827)

f. Type of Firearms Dealer

	Retail	Pawnshop	Other	Total
% under 4 years	42.2%	46.8%	35.8%	43.3%
Total	(37115)	(14006)	(862)	(51983)

It is also possible that dealers who are less compliant with firearms commerce rules and regulations may be more likely to be involved in negligent business practices or illegal gun trafficking.

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When active licensed dealers are not initially responsive to an ATF request for sales information on a recovered crime gun, ATF issues a 13-day request letter to the dealer for the information. For dealers with 3 to 4 request letters, 48.7% of the traced guns had a time-to-crime less than 4 years, but the percent of short time-to-crime traces drops to 44.2% for dealers with 4 to 9 letters and then rises to 58.6% for dealers with 10 or more request letters (see Table 2d). Finally, the type of dealer and the number of NICS denials per dealer show small relationships with the time-to-crime of traced guns (see Table 2e and Table 2f).

Table 3. Time-to-Crime by Crime Gun Purchaser Level Indicators

a. Time to Crime: Number of Crime Gun Traces

	1 Trace	2+ Traces	Total
% Under 4 years	28.7%	54.6%	31.2%
Total	(74655)	(8082)	(82737)

b. Time to Crime: Total Traces to Purchaser Home Zip Code

	1–5	6–10	11–25	26–50	51+	Total
% Under 4 years	24.0%	27.8%	32.1%	36.8%	49.5%	32.2%
Total	(23059)	(14094)	(19398)	(10997)	(11598)	(79137)

c. Time to Crime: Purchaser Age

	18–24	25–29	30–39	40+	Total
% Under 4 years	42.5%	34.2%	28.3%	26.4%	32.3%
Total	(18551)	(14819)	(21422)	(22955)	(77747)

We illustrate the percentage of short time-to-crime crime guns by potential purchaser-related indicators of gun trafficking in Table 3. When the first retail purchaser was associated with two or more crime gun traces, 54.6% of the traced crime guns were recovered within 4 years of the purchase, versus 28.7% when only one firearm was traced to an individual purchaser (see Table 3a). The relationship between time-to-crime and total traces associated with a first purchaser's home zip code was developed as an indicator of potential crime gun trafficking networks within the residential communities of crime gun purchasers. When the purchaser's home zip code has more than 50 crime guns traced to it, nearly 49.5% of the traced crime guns have a time-to-crime of less than four years (see Table 3b). In contrast, only 27.8% of crime gun traces in purchaser neighborhoods associated with 10 or fewer traces have a time-to-crime of fewer than 4 years. Finally, younger

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retail purchasers are associated with shorter time-to-crime (see Table 3c).

For those traced guns where the possessor and the purchaser were different people, firearm trace data allow us to develop indicators that examine potentially "close" relationships between the crime gun purchaser and possessor. Shorter time-to-crime guns are associated with purchasers and possessors who live closer together (see Table 4a). When the residence of the purchaser was within 5 miles of the residence of the possessor, 43.9% of the traced guns had a time-to-crime of fewer than 4 years, versus only 18.5% for those who live more than 500 miles from each other. When the purchaser and possessor were within 4 years of age, almost 44% of the traced guns had a quick time-to-crime, versus 23.4% for purchasers and possessors with a 20-year or greater age difference (see Table 4b). We also examined the possibility of familial relationships influencing time-to-crime. In this analysis, we simply used whether the purchaser and possessor had the same last name, but different first names, as a measure of relationship. We found that 44.5% of the crime guns originating from different purchasers and possessors with the same last name had a time-to-crime of less than 4 years, versus 29.5% when the last name was different (see Table 4c). These results conform to the findings of other research that suggests that youth and criminals often acquire guns from friends and family members (e.g., Wright and Rossi 1994; ATF 2000a).

Some police departments submit information on known associates of crime gun possessors with the crime gun possessor information to the National Tracing Center. For traces in which associate and possessor information had been submitted, when a known associate of the crime gun possessor was also the first retail purchaser of the traced crime gun, 73.8% of the recovered crime guns had a fast time-to-crime (Table 4d). Among the subset of traces in which the associate of a crime gun possessor was not the original purchaser, when a known associate of the criminal possessor lived within 5 miles of the original purchaser, 58.9% of the traces had a time-to-crime of fewer than 4 years (Table 4e). Although these data cannot unravel whether the associate and the purchaser knew each other, for fast time-to-crime guns, this information can certainly be regarded as an investigative lead.

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Table 4. Time-to-Crime by Purchaser/Possessor Relationship Indicators

a. Purchaser/Possessor Residential Proximity								
Miles	0-5	6-10	11-25	26 - 50	51 - 100	101 - 500	500+	Total
% Under 4 years	43.9%	32.9%	29.7%	22.7%	22.8%	20.3%	18.5%	30.4%
Total	(10275)	(4447)	(4984)	(2401)	(1797)	(5302)	(5031)	(34237)

b. Purchaser/Possessor Age Proximity					
Years	0 - 4	5 - 9	10 - 19	20+	Total
% Under 4 years	43.8%	29.5%	22.9%	23.5%	30.2%
Total	(10713)	(8294)	(10527)	(9229)	(38763)

c. Potential Family Relationship Between Purchaser/Possessor			
Last Name	Not Same	Same	Total
% Under 4 years	29.5%	44.5%	30.3%
Total	(47294)	(2847)	(50141)

d. Relationship Status of Associate of Possessor to Purchaser			
	Associate is	Associate	Total
% Under 4 years	34.1%	73.8%	36.1%
Total	(7750)	(412)	(8162)

e. Purchaser to Associate of Possessor Residential Proximity						
Miles	0	1-5	6-10	11-25	26+	Total
% Under 4 years	58.9%	45.1%	33.2%	28.5%	24.4%	34.1%
Total	(750)	(867)	(722)	(748)	(2390)	(5477)

Time-to-crime by age of crime gun possessors and the number of crime guns traces to home zip code of the possessor are other possible indicators. Young adults (possessors aged 18 to 29) are more likely to possess short time-to-crime guns than either their younger or older counterparts (Table 5a). There is very little relationship between the time-to-crime and the number of traces to the home zip code of the possessor (Table 5b).

Table 5. Time-to-Crime by Crime Gun Possessor Level Indicators

a. Time to Crime by Possessor Age						
Age	11 - 17	18 - 24	25 - 29	30 - 39	40+	Total
% Under 4 years	27.1%	41.0%	40.0%	31.5%	22.0%	33.3%
Total number	(2972)	(15431)	(8030)	(10609)	(12079)	(49121)

b. Total Traces to Zip of Possessor Home Location							
Time to Crime	0	1-5	6-10	11-25	26-50	51+	Total
Under 4 years	33.8%	32.7%	32.7%	32.6%	36.3%	34.9%	33.6%
Total Number	(32493)	(8899)	(4058)	(5412)	(3626)	(2697)	(57185)

Multivariate Analysis of Selected Gun Trafficking Indicators

We conducted a multivariate analysis of the independent effect of each illegal gun trafficking indicator on time-to-crime to

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determine whether those we identified remained significant predictors. The variables were examined for their relevance in trafficking. The effects of the indicators, and of the control variables, are assessed in terms of the substantive/temporal category in which they enter the trafficking process. We can thus examine to what extent the effects are mediated when other variables are introduced later in the process. We also examine the overall effect of each variable in terms of the last stage in the analysis that includes it.

The indicators and control variables included in this analysis are listed in Table 6. For those variables that represented counts of events (e.g., the number of traces from a specific dealer to a recovery location), we transformed the variable by taking the natural log. As Tufte (1974) suggests, taking the natural log of count data results in a smoother distribution that better represents the functional form of the data. Dummy variables were used for dichotomous independent variables (e.g. whether the dealer shelf life of a traced crime gun was greater than 2 years).

The sample for the multivariate analysis of time-to-crime was restricted to traces for which the purchaser and possessor were identified as different individuals, the activity or inactivity of a dealer was identified, and a time-to-crime was available. The sample was restricted this way because the situation where purchaser and possessor of crime-related guns are different people represents the far more common pattern. Of the 82,731 firearms traces with a time-to-crime, in 50,141 the purchaser and possessor were different people, in 6,305 they were the same, and in 26,291 there wasn't enough information to know. Of the 50,141 there were 348 traces for which the activity of a dealer could not be identified. The final sample for the analysis therefore consisted of 49,793 traces.

The level of missing data varied across indicator and control variables. There are many techniques available to deal with the problem of missing data in multivariate analyses (for a full discussion see Little & Rubin, 1987). We included dummy variables to control for the missing information. Also, because traces associated with inactive dealers tend to have a longer time-to-crime, the relationship between time-to-crime and dealer characteristics—such as the number of traces from a dealer to a recovery city—could be artificially increased. To control for this potential bias we included a dummy variable that identified all active dealers (62% in the sample). The coefficients for the dummy variables are not shown, but are available on request.

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Table 6. Multivariate Cox Regression Model Variables

Model Block/Stages	Variable Name	Variable Description
Stage 1 - Dealer	1. LN_Dealer_traces	Natural log of the number of traces from an active dealer to a recovery city
	2. LN_Dealer_multsale	Natural log of the number of multiple sale guns sold by an active dealer
	3. LN_13_day_ltr	Natural log of 13 day request letters to a dealer
	4. LN_NIC_denials	Natural log of NIC check denials by a dealer
	5. Pawnshop	Dealer a pawn shop
	6. Shelf_life	Shelf life of crime gun two plus years
	7. Pur_law	Dummy variable for state permit-to-purchase and registration systems
Stage 2 - Purchaser	8. Pur1824	Purchaser age 18-24
	9. Pur2529	Purchaser age 25-29
	10. Pur3039	Purchaser age 31-39
	11. Traces/pur	Number of traces to a purchaser
	12. LN_Traces/purzip	Natural log of number of traces from a purchaser's home zip code
Stage 3 - Purch/Possessor	13. LN_age_pur/pos	Natural log of the difference between purchaser/possessor age
	14. LN_dist_pur/pos	Natural log of the distance between purchaser/possessors home residence
	15. Pur_same_fam	Possessor and purchaser have same last name
	16. Associate_pur(1)	Possessors has a known associate that is the purchaser
	17. Associate_pur(2)	Associate of Possessors lives within 5 miles of purchaser
Stage 4 - Possessor	18. Pos17	Possessor's age under 18
	19. Pos1824	Possessor's age 18-24
	20. Pos2529	Possessor's age 25-29
	21. Pos3039	Possessor's age 30-39
	22. LN_Traces/poszip	Natural log of number of traces associated with a possessor's home zip code
Stage 5 - Crime Gun	23. Firearm-pistol	Crime gun a pistol
	24. Firearms-stolen	Crime gun identified as stolen from NICI records

Data that measure lifetimes or the time until an event are generally called survival data (Lee, 1992). In this analysis, we are interested in modeling the time between the first retail sale of a firearm and its subsequent recovery in crime by law enforcement. Survival data have special considerations that must be incorporated into the analysis. The purpose of survival analysis is to model the underlying distribution of the event-time variable and to assess the dependence of the event-time variable on the

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independent variables. Survival data are often censored. As discussed, a small number of cases in this data set are right censored due to constraints on the measurement of time-to-crime. Survival analyses take the censoring into account and correctly use the censored observations as well as the uncensored observations (for a discussion of the numerous possible censoring schemes that arise in survival analyses see Maddala, 1983).

We use the Cox proportional hazards model to analyze the time-to-crime (failure time) for guns in our data set (Lee, 1992). This model does not impose a distributional assumption on the underlying probability process of the time between the first retail sale of a gun and its subsequent recovery. In this way, the Cox model is more robust than other duration-time methods, specifically those based on probability distributions, such as the exponential or Weibull models (Lee, 1992). The Cox model can be written as: $h(t \mid x) = h_0(t)g(x)$.

In this specification, $h_0(t)$ is the baseline hazard at time t independent of covariates and g(x) is a function of the covariate matrix X that includes our independent variables. The proportional hazards model is thus a multiplicative form of the baseline hazard where solving the above equation for g(x) gives the ratio of the hazard in time t given x to the baseline hazard, $h(t \mid x)/h_0(t)$. Estimation of the model is done in the log form and produces a vector of βs, one for each independent variable, which represent the log effect of the covariate on the hazard ratio. The standard errors of the βs are used to test for statistical significance; for discussion of the effects of the covariates, we focus on the relative risk measures.

We estimate the effect of each independent variable on the relative risk that a gun with this characteristic is traced in time t. The relative risk is simply the ratio of the probability of failure, hazard, in time t adjusted for a covariate, to the baseline hazard at time t, $h(t \mid x)/h_0(t)$. Thus there is a relative risk associated with each independent variable. In a model where all independent variables are dichotomous, the relative risk is simply $\exp(\beta i)$ and represents the likelihood of a trace for a gun with the specified characteristic relative to the baseline hazard of a trace. Because our model also includes continuous independent variables, the relative risk measures reported here indicate the likelihood of a trace for a gun with the specified characteristic relative to a gun at the mean value of all continuously measured characteristics and without characteristics measured by dichotomous indicators.

The interpretation of the relative risk measure is similar to that of the odds ratio. A relative risk, or hazard ratio, equal to 1

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indicates that the adjusted hazard is the same as the baseline, i.e., equal risk of a trace for a gun with the characteristic as for one without it. As the relative risk associated with a specific independent variable falls below one, the likelihood that a gun with that characteristic is traced in time t is less than the baseline; of course, the opposite is true if the relative risk is greater than one. For the duration time (time-to-crime) model, then, a relative risk of .5 for a particular variable indicates a 50% drop in the time-to-crime for a gun with this characteristic with respect to the baseline for a gun without this characteristic. Correspondingly, a relative risk of 1.5 indicates a 50% increase in the time-to-crime for a gun with this characteristic.

The coefficients for the Cox regression model are presented in Table 7. Of the 49,793 firearm traces in the analysis, 4,246 firearms with time-to-crime greater than 20 years were censored because federally licensed dealers are not required to maintain records on the sale and purchase of firearms beyond that time. Although many dealers continue to maintain records beyond the 20-year limit, the quality and consistency of time-to-crime measurements decrease to an unknown degree.

Omnibus tests of the model coefficients show that each successive stage in the Cox regression model produced a significant ($p<.00001$) iterative improvement in change to the model Chi-square from the previous step.

Dealer-related indicators are assessed when stage 1 variables first enter the model. When dealer-related indicator and control variables first enter the regression model three of the four indicator variables (the natural log of traces from a specific dealer to a recovery location, the natural log of number of multiple sale firearms sold by a given dealer, and the shelf life of a crime gun) are significant predictors of time-to-crime controlling on other variables in stage 1. The natural log of 13-day request letters to a dealer is not a significant predictor of time-to-crime controlling for the other dealer level indicator variables. This result may indicate that 13-day letter requests by ATF to a dealer indicate sloppy dealer paperwork more than a dealer's desire to hide potentially illegal transactions. Perhaps it captures both, which would limit its use as an indicator. The analysis of stage 1 results indicates that three (see variables 1, 2, and 3 in Table 7) of four original indicators of dealer-related sources of trafficking remain significant

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Table 7. Cox Regression Results for Purchaser/Possessor Different Person

Stage (s)	1			1, 2			1, 2, 3			1, 2, 3, 4			1, 2, 3, 4, 5		
Variables	B	Sig.	Exp(B)	B	Sig.	Exp(B)	B	Sig.	Exp(B)	B	Sig.	Exp(B)	B	Sig.	Exp(B)
LN_Dealer_multsale	.063	.000	1.065	.056	.000	1.057	.058	.000	1.059	.056	.000	1.058	.036	.000	1.037
LN_13_day_ltr	-.010	.159	.990	-.027	.000	.974	-.024	.001	.976	-.026	.000	.975	-.022	.003	.978
LN_NIC_denials	.028	.000	1.028	.029	.000	1.030	.030	.000	1.031	.030	.000	1.031	.038	.000	1.039
Pawnshop	.214	.000	1.239	.199	.000	1.220	.213	.000	1.237	.205	.000	1.227	.118	.000	1.125
Shelf_life	.222	.000	1.248	.230	.000	1.259	.218	.000	1.243	.226	.000	1.254	.294	.000	1.342
Pur_law	-.208	.000	.812	-.164	.000	.849	-.191	.000	.827	-.190	.000	.827	-.124	.000	.884
Pur1824				.207	.000	1.230	.112	.000	1.119	.086	.000	1.090	.053	.000	1.055
Pur2529				.086	.000	1.090	.006	.683	1.006	-.009	.534	.991	-.041	.006	.959
Pur3039				.058	.000	1.060	-.013	.307	.987	-.017	.207	.983	-.032	.014	.968
Traces/pur				.554	.000	1.741	.507	.000	1.661	.522	.000	1.686	.518	.000	1.679
LN_Traces/purzip				.068	.000	1.070	.052	.000	1.054	.049	.000	1.050	.043	.000	1.044
LN_age_pur/pos							-.148	.000	.862	-.131	.000	.877	-.118	.000	.889
LN_dist_pur/pos							-.056	.000	.945	-.060	.000	.942	-.066	.000	.936
Pur_same_fam							-.008	.710	.992	.021	.336	1.021	.075	.001	1.078
Associate_pur(1)							.441	.000	1.554	.488	.000	1.629	.462	.000	1.588
Associate_pur(2)							.105	.000	1.111	.070	.012	1.073	.062	.027	1.064
Pos17										.202	.000	1.224	.073	.002	1.076
Pos1824										.355	.000	1.427	.249	.000	1.282
Pos2529										.295	.000	1.343	.204	.000	1.226
Pos3039										.163	.000	1.177	.125	.000	1.133
LN_Traces/poszip										-.008	.036	.992	-.001	.722	.999
Firearm-pistol													.653	.000	1.920
Firearms-stolen													.016	.596	1.016

predictors of time-to-crime. The dealer-related indicators remain significant even while controlling for the level of criminally involved customers frequenting a dealer (i.e., the log of the number of NICS check denials by a dealer), the type of dealer that originally sold the firearm, and whether states have restrictive state gun laws. Restrictive state gun purchaser laws were statistically associated with a longer time-to-crime.

Purchaser-related indicator variables enter the model in stage 2. Both individual and neighborhood purchaser indicators are significant predictors of time-to-crime controlling for the other variables in stages 1 and 2. Interestingly, the neighborhood variable—the natural log of the number of traces from a purchaser's home zip code—remains a significant predictor of time-to-crime, along with purchasers associated with two or more traces. This suggests that neighborhood factors, perhaps through the operation of a network of traffickers, may have an effect on trafficking at least partially independent of gun purchasers living in the community.

Purchaser/possessor variables enter the model in stage 3. The natural log of the absolute difference between a purchaser's and possessor's age, the natural log of the distance between a purchaser and possessor's home, a dummy variable indicating that the possessor has an associate who was the purchaser, and a dummy variable indicating an associate of the possessor lives within 5 miles of the purchaser's home are significant predictors of time-to-crime controlling for all the variables in stages 1 through 3. Only the variable that identified whether a possessor had the same last name as a purchaser was not significantly related to time-to-crime.

Stages 4 and 5 examine potential possessor and firearm indicators and control variables. Stage 4 examines the natural log of the number of traces associated with the home zip code of a possessor and dummy variables for possessor's age. Of the variables entered in stage 4, only the possessor's home zip code is not significant. The dummy variables for possessor's age are, however, with the age group 18 to 24 being the strongest predictor. For the variables entered in stage 5, the type of weapon traced is a significant predictor, but whether the weapon was reported stolen to NCIC is not. Dealer and restrictive gun law variables remain statistically significant at stage 5, though their effects have been somewhat reduced. Purchaser/possessor relationship variables also remain statistically significant and for the most part undiminished, supporting the case for potentially cooperative relationships between purchaser and possessor.

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In developing our crime-gun indicators we began with a simple table of bivariate correlations and progressed to a multivariate analysis of variables grouped by likely availability of information. The multivariate models serve two purposes: First, they confirm the findings in the bivariate analysis; and, second, they demonstrate that potential crime-guns indicators hold up even when adjusted for covariation with other significant variables. From a policy perspective, the availability of information and consequent measurability of indicators are important considerations in implementing any potential investigation scheme.

As we added variables to our multivariate model, beginning with the gun dealer characteristics and followed by information about both the purchaser and the purchaser/possessor relationship, we observed that the effects of dealer characteristics remained statistically significant, but were reduced in magnitude. This behavior was anticipated: after all, purchaser and possessor information is likely to track more closely with crime-gun usage.

The assessment of the total effect of a particular attribute can best be interpreted at the stage the attribute enters the model, assuming the time sequence we propose is an accurate characterization. Thus, in the case of the dealer attribute—the number of traces from a dealer to a recovery city/location—we can interpret the total effect of that variable as 1.067, which is the Exp(B) coefficient in the stage 1 model.

For assessing the potential overall contribution of a particular variable, we can examine the final stage, 5, that includes each of the independent variables. Using these results we can differentiate lower from higher indicators. Selected purchaser indicators, the number of traces to a purchaser (Traces/pur) and an associate of the possessor being the purchaser (Associate_pur1), showed the greatest effect (the Exp(B) coefficient) on time-to-crime. The dealer indicators exhibit lowest magnitudes of effect with the exception of the indicator, shelf life (Shelf_life). The remaining purchaser and purchaser/possessor relationship variables show magnitudes that fall between the higher and lower estimates.[7]

[7] One caveat should be made relative to the dealer level indicator, the number of traces from a dealer to a recovery location (LN_Dealer_traces). A version of this variable that is restricted to the number of short time-to-crime traces from a dealer to a recovery location may be a better indicator of potential trafficking. However, this measure could not be used in the present analysis because it would be confounded with the time-to-crime measure.

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Variation in Gun Trafficking Indicators Across Cities

As Braga and his colleagues (2002) suggest, the importance of point sources of illegal firearms may vary across cities according to the tightness of state controls on legitimate firearms commerce. We sought to examine this and overall variability of trafficking indicators across cities. From the multivariate analyses, we can identify those indicators of potential gun trafficking that remain statistically significant predictors of reductions in the time-to-crime of successfully traced crime guns. To avoid overestimating the presence of gun trafficking indicators among traced crime guns, we dropped two prospective indicators identified in our simple bivariate analyses. The indicator "purchaser and possessor have the same last name (but are different people)" was dropped because, when other variables were controlled for, it was not statistically significant. The indicator "2 or more 13-day request letters" was dropped because, when other variables were controlled for, its estimated effect was in the opposite direction (although significant) from what was found in the bivariate analyses. As noted earlier, the results of the multivariate analysis may indicate that the 13-day letter is more a product of sloppy dealer paperwork than of a dealer's desire to obscure or hide potentially illegal transactions. At the least, this indicator is compromised in that it captures both types of behavior. While this indicator is not statistically significant in the initial models, the potentially dual character of the 13-day letter measure appears to reveal itself when other measures of firearms trafficking are controlled for in the multivariate analysis.

For each of the indicators, predictive cut-off points were selected based on the relationship of a given indicator to time-to-crime. More specifically, cut-offs were selected based on the approximate value for a given attribute beyond which there was no consistent improvement in time-to-crime. Because these indicators were derived from national data, it was entirely possible to select other cut-off points for these indicators at the city level. The analysis was simply an exercise exploring the utility of various gun trafficking indicators. Our intent was to develop a framework for identifying leads on potential gun traffickers that was robust but also flexible. Analysts and investigators using these indicators should be encouraged to customize the cut-off points to the nature of crime gun problems in their jurisdictions. For example, Boston, which recovers several hundred guns per year, would want to use different criteria than New York City, which recovers many thousands.

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In addition to the nine indicators identified as robust predictors of a significant reduction in time-to-crime in our multivariate analyses, we included one additional indicator that law enforcement investigators and analysts consider a valuable sign of potential firearms trafficking—crime guns that were part of a multiple gun sale purchase (ATF, 2000c). We did not include this indicator in our analyses of time-to-crime because multiple gun sale records have been required only since 1994 and, as a result, this indicator would have been biased towards shorter time-to-crime for guns recovered in 1999. We assessed whether this law-enforcement-generated gun trafficking indicator was highly correlated with our nine data-derived indicators of gun trafficking. The highest bivariate correlation of the multiple gun sale indicator with any other gun trafficking indicator was 0.209 (with more than 1 trace to a specific purchaser) and seven of the bivariate correlations were less than 0.1. The 10 gun trafficking indicators were reduced into a single measure of trafficking.

We examined the question of cross-city variation in firearms trafficking indicators by looking at the distribution of the total gun trafficking index across the seven selected cities (Table 8). Boston and New York are in states with relatively tight gun controls. These cities have the highest percentage of firearm traces without any indicators of firearms being rapidly diverted from legitimate retail commerce (Boston, 57.9%; New York, 55.0%). Only 12.5% of the Boston traces and 15.6% of the New York traces have two or more gun trafficking indicators. The stringency of state laws makes it more difficult to exploit easy opportunities for trafficking firearms from in-state licensed dealers. Boston and New York are also known for having a large number of crime guns imported from dealers residing in states with less strict gun control laws (Cook & Braga, 2001). However, both cities have well-publicized firearms trafficking programs in place that actively focus on guns recently diverted from in-state and out-of-state retail outlets (Kennedy et al., 1996; ATF, 1997). This increased focus on close-to-retail diversions of guns may have discouraged some gun traffickers from acquiring new firearms at gun stores. Given the patterns in the data, we could speculate that the effect of these efforts may have been to make criminals seek guns from other illegal gun market sources such as point sources in the largely unregulated secondary market or more diffuse sources such as theft.

The other five cities had much higher percentages of guns with two or more gun trafficking indicators (Table 8). Milwaukee and Philadelphia had the highest percentages of crime guns with two or more trafficking indicators (59.4% and 48.7%, respectively),

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followed by Baltimore (46.9%), Memphis (41.1%), and San Antonio (31.6%). These data suggest that firearms recently trafficked from retail outlets comprise significant portions of illegal markets in firearms through which criminals and youth acquire firearms in these cities. As such, strategic analyses of firearms trace data could be used to good effect in identifying point sources of illegally trafficked guns and developing appropriate problem-solving interventions to shut down these supply lines. Milwaukee and Philadelphia had significant numbers of traces with 3 or more gun trafficking indicators. A supply-side gun market disruption strategy focused on quick diversions of guns from federally licensed dealers may prove to be particularly fruitful in these cities.

Table 8. Distribution of Traces by Total Trace Indicators Index by Recovery City

	Recovery City							
Total Index	Balto.	Boston	Memphis	Milw.	New York	San Antonio	Phila.	Total
0 Indicators	29.4%	57.9%	27.0%	22.8%	55.0%	37.4%	21.9%	35.3%
1 Indicator	23.7%	29.6%	31.9%	17.8%	29.4%	31.0%	19.4%	26.1%
2 Indicators	22.2%	8.2%	21.2%	13.9%	10.8%	18.4%	19.2%	16.9%
3+ Indicators	24.7%	4.3%	19.9%	45.5%	4.8%	13.2%	39.5%	21.7%
Total percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Total number	(2,039)	(233)	(1,941)	(1,307)	(3,113)	(903)	(1,738)	(11,274)

DISCUSSION

We focused on one aspect of the illegal guns markets that holds immediate promise for focused regulatory and enforcement efforts based on strategic analyses of firearms trace data—close-to-retail diversions of new guns. We understand that the important pathways of gun trafficking for particular types of offenders at any given moment may not be important in a year's time. For example, if law enforcement shuts down the supply of new, trafficked guns to youth and their demand for firearms remains constant, we recognize that another source of guns, perhaps stolen firearms, may absorb much of the demand and existing interventions focused on close-to-retail diversions may not yield a net reduction in the availability of guns to youth. This is precisely the reason that developing new crime intelligence methodologies to analyze local gun markets is key to improving the capacity of local jurisdictions to respond to illegal gun trafficking. If proven methodologies exist to identify pathways of gun trafficking, law enforcement agencies

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can reassess the situation, diagnose the alternate supply channel, and implement a response to reduce the flow of guns to the street. This fits well with the problem-oriented policing philosophy and advances a key component of the process—the analysis of problems.

The case for focusing regulatory and enforcement efforts on the illegal supply of firearms to criminals rests on the belief that a supply-side approach has the potential to reduce the use of guns in violence. However, to some observers, efforts to reduce gun violence by restricting the supply are futile since guns in America are readily available from a wide variety of sources.

The findings of this research suggest that it is possible to use firearms trace data to identify the workings of illegal firearms markets and develop appropriate problem-oriented interventions to shut down direct supply lines of guns to criminals and juveniles. Our results indicate that a noteworthy percentage of the guns recovered in crime come rather directly from licensed dealers; in effect criminals are being supplied by dedicated "pipelines" as well as the extant pool of guns (Braga et al., 2002). Almost one-third of traceable 1999 crime guns were fast time-to-crime guns and nearly a third of all 1999 traced crime guns had two or more indicators of gun trafficking. These data analyses suggest that a significant share of guns that are recovered from criminals could be affected by supply-side interventions that focus on guns recently diverted from retail sources. It is also important to note that many illegally diverted firearms may not be recovered by law enforcement agencies. An investigation of one gun with multiple trafficking indicators might uncover a much larger gun trafficking enterprise involved in the illegal diversion of a multitude of guns that have not yet come to the attention of law enforcement.

The gun trafficking indicators developed in this research allow law enforcement to assess the investigative potential of particular gun traces so they can focus their limited resources on the parts of the illegal gun market comprised of direct supply lines of guns from retail sources to criminals and youth. These indicators essentially focus investigators on gun sales and purchasing patterns that should receive closer scrutiny. The nature of illegal gun markets varies across states and metropolitan areas and, as such, local law enforcement agencies partnered with ATF Field Divisions will want to tailor these indicators appropriately.

By analyzing the nature of particular gun trafficking problems, law enforcement can develop a systematic plan to shut down supply lines rather than simply pursuing ad-hoc enforcement actions on specific individuals. For example, these analyses could

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reveal that a particular community suffers from a large number of unrelated small-scale straw purchases. Due to limited enforcement resources, pursuing enforcement actions against a large number of individual straw purchasers may not be feasible. However, after this problem has been identified, alternative approaches can be crafted. A priori, it is difficult to specify what such an approach would look like. It may be fruitful for law enforcement to focus prosecutions on those straw purchasers whose guns were recovered in serious circumstances, identify straw purchasers of guns recovered with no serious consequences and educate them on the risks involved in making illegal transfers, and explicitly communicate the problem and associated law enforcement actions to the entire community. Whatever form such a problem-oriented response takes, strategic analyses of firearms trace data, supported by the working knowledge of front-line law enforcement agents, can go far in developing an appropriate and effective plan.

The complexity and diversity of illegal gun markets suggest that there is no single best policy or approach to disrupting the illegal supply of guns within the United States. We believe that jurisdictions interested in reducing the availability of guns should develop a portfolio of interventions based on problem-solving partnerships between federal, state, and local authorities. Problem-oriented policing holds great promise for creating a strong response to illicit firearms markets. Problem-oriented policing works to identify why things are going wrong and to frame responses using a wide variety of often-untraditional approaches. Using a basic iterative approach of problem identification, analysis, response, evaluation, and adjustment of the response, problem-oriented policing has been effective against a wide variety of crime, fear, and disorder concerns (Goldstein, 1990; Eck & Spelman, 1987; Braga, Weisburd, Waring, Green-Mazerolle, Spelman, & Gajewki, 1999). This adaptable and dynamic analytic approach provides an appropriate framework to uncover the complex mechanisms at play in illicit firearms markets and to develop tailor-made interventions to disrupt the gun trade.

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